## Optimal Emergency Shipment Policy for a Single-Echelon Periodic Review Inventory System

Authors : Saeed Poormoaied, Zumbul Atan

Abstract : Emergency shipments provide a powerful mechanism to alleviate the risk of imminent stock-outs and can result in substantial benefits in an inventory system. Customer satisfaction and high service level are immediate consequences of utilizing emergency shipments. In this paper, we consider a single-echelon periodic review inventory system consisting of a single local warehouse, being replenished from a central warehouse with ample capacity in an infinite horizon setting. Since the structure of the optimal policy appears to be complicated, we analyze this problem under an order-up-to-S inventory control policy framework, the (S, T) policy, with the emergency shipment consideration. In each period of the periodic review policy, there is a single opportunity at any point of time for the emergency shipment so that in case of stock-outs, an emergency shipment is requested. The goal is to determine the timing and amount of the emergency shipment during a period (emergency shipment policy) as well as the base stock periodic review policy parameters (replenishment policy). We show that how taking advantage of having an emergency shipment during periods improves the performance of the classical (S, T) policy, especially when fixed and unit emergency shipment costs are small. Investigating the structure of the objective function, we develop an exact algorithm for finding the optimal solution. We also provide a heuristic and an approximation algorithm for the periodic review inventory system problem. The experimental analyses indicate that the heuristic algorithm is computationally more efficient than the approximation algorithm, but in terms of the solution efficiency, the approximation algorithm performs very well. We achieve up to 13% cost savings in the (S, T) policy if we apply the proposed emergency shipment policy. Moreover, our computational results reveal that the approximated solution is often within 0.21% of the globally optimal solution.

Keywords : emergency shipment, inventory, periodic review policy, approximation algorithm.

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